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REMARKS

Applicants have received and reviewed the Office Action dated January 24, 2007. Claims 1-2 and 5-8 are pending in the current application. Applicants submit that the pending claims are supported by the specification.

For the reasons given below, Applicants submit that the claims are in condition for allowance and notification to that effect is earnestly solicited.

Claim rejections under 35 U.S.C. § 103(a)

Claims 1-2 and 5-8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Clarkson et al. (U.S. Patent No. 6,919,290) taken together with Voecks (U.S. Pub. No. 2004/0206618 A1). Applicants respectfully traverse the rejection.

To make a *prima facie* case of obviousness, three criteria must be met. There must be (i) a teaching or suggestion in the cited references to modify the references or combine the teachings of the references; (ii) a reasonable expectation of success, and (iii) a teaching or suggestion of all the claim limitations on a cited reference, or combination of reference. See *In re Vaeck*, 947 F.2d 488 (Fed. Cir. 1991). The Examiner has the burden to establish a *prima facie* case of obviousness. Furthermore, the Examiner cannot rely on the skill in the art alone to provide the necessary teaching or suggestion. Such a suggestion must appear in the cited references. *Al-Site Corp. v. VSI Int'l, Inc.*, 174 F.3d 1308 (Fed. Cir. 1999).

Applicants claim methods of reducing catalysts containing a metal compound using a mixture of hydrogen gas and an inert gas under a non-thermal plasma state. Conventional reduction methods employ high temperatures (see page 2, lines 5-7 of the present application). The claimed methods eliminate the need for devices to provide high temperatures, eliminate the time required to heat the system prior to commencing the reduction reaction, and result in catalysts without loss of efficiency -- and even improved efficiency in some cases -- in a hydrocarbon conversion process (see Tables 1 and 2).

Clarkson et al. disclose a conventional thermal method for activating a catalyst with hydrogen. As Clarkson et al. explain, their object is to provide an effective activation procedure

for Fisher-Tropsch catalysts under conditions within the normal operating parameters for a Fisher-Tropsch reaction (column 2 line 8). As acknowledged in the Office Action, Clarkson et al. do not disclose the use of non-thermal plasma. Clarkson et al. employ plasma at temperatures corresponding to the activation temperature of the catalyst, typically 210°C – 260°C (column 3 lines 1-2).

Voecks teaches the use of a non-thermal plasma technique to enhance the efficiency of a catalytic reaction process. The process does not result in catalyst reduction. Voecks discloses a method to increase the total reaction conversion of carbon monoxide to carbon dioxide by oxidizing with water (steam) in the presence of a metal oxide catalyst. See page 3, paragraph [0024] and experiments on page 2, paragraphs [0020-0022] of Voecks. The catalysts employed for the reaction are copper/zinc oxide combination, noble metal oxides, or metal oxides (page 2, paragraph [0017]). Voecks teaches the use of a non-thermal plasma in which to increase the total conversion of the reaction.

The Office Action asserts it would be *prima facie* obvious to utilize the non-thermal plasma of Voecks to accelerate the catalytic process of Clarkson because Voecks teaches that the non-thermal plasma accelerates reactions.

The combination of Clarkson et al. with Voecks is improper and would not result in Applicants' method. The combination instead would result in a Fisher-Tropsch catalyst subjected to water vapor and carbon dioxide under non-thermal plasma to oxidize carbon monoxide to carbon dioxide. Such a system would be inoperative, as Fisher-Tropsch catalysts are not useful to oxidize carbon monoxide; such catalysts are used in the petroleum industry to convert carbon monoxide and hydrogen into liquid hydrocarbons and in fact the two species of catalysts are mutually exclusive: catalysts used to convert carbon monoxide to carbon dioxide are specifically not useful as Fischer-Tropsch catalysts (see Abstract and paragraph 3 of the article, Journal of Natural Gas Chemistry 13(2004)1-9, page 1 attached). If under such conditions the catalyst oxidized, it would not be effective for its purpose of reducing carbon monoxide.

Alternatively, it may be contemplated that the combination of references would enable the reduction metal oxide catalysts of Voecks by virtue of the non-thermal plasma conditions. However, no hydrogen is employed in Voecks; thus catalyst reduction would not occur. Further, if hydrogen (per Clarkson et al.) were supplied under non-thermal plasma prior to introducing

carbon monoxide and water, and the metal oxide catalysts were reduced, the reduced catalysts would be ineffective in oxidation reactions of Voecks, because only metal oxides will carry out such a reaction; in addition the reduced catalysts would immediately oxidize in the presence of water while subjected to the plasma discharge.

Thus, the combination of cited references results in an inoperative reaction system. If a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). Further, there could be no reasonable expectation of success in using the conditions of Voecks to reduce the catalysts of Clarkson, as hydrogen gas was not employed by Voecks and Voecks does not teach that catalysts can be reduced by non-thermal plasma.

There can be no plausible suggestion by Voecks that the conditions for oxidizing carbon monoxide would be effective for reducing catalyst is the presence of hydrogen-containing gas. To the contrary, Voecks teaches away from using hydrogen in the presence of low temperature plasma to reduce metal oxides to metal, as such metal species are inoperative for oxidation reactions such as conversion of carbon monoxide to carbon dioxide. Nor is there any suggestion that using only some of the conditions of Voecks, i.e. removing the reagents carbon monoxide and water and replacing them with hydrogen gas, would be effective in reducing metal oxides to metal on the surface of metal catalysts such as Fischer-Tropsch catalysts of Clarkson et al. The fact that to reach Applicants' invention requires the use of only some elements of the cited references, but not others, is further evidence of the nonobviousness of Applicants' invention.

In the Office Action the Examiner appears to take official notice that one of skill in the art would in fact realize, upon reading the cited references, that employing only the low-temperature plasma element from the entire set of conditions set forth in the oxidation reactions of Voecks, and employing that one element in combination with the catalysts of Clarkson et al., would result in a reduction of the catalysts of Clarkson et al. without having to heat the system to accomplish the reduction. As there is no other stated basis for this assertion, Applicants submit that the Examiner's assertion is based on knowledge common to those of skill in the art.

However, in taking official notice, it is never appropriate for the Examiner to rely only on common knowledge in the art. Rather, the Examiner must support the facts with documentary evidence demonstrating that the asserted facts are well known in the art. The Examiner has failed

to provide documentary evidence that it would have been obvious to one of skill in the art to modify the conditions of Voecks and Clarkson et al. to reach Applicants' method of catalyst reduction. See *In re Zurko*, 258 F.3d 1379, 1385 (Fed. Cir. 2001) ("[T]he Board cannot simply reach conclusions based on its own understanding or experience—or on its assessment of what would be basic knowledge or common sense. Rather, the Board must point to some concrete evidence in the record in support of these findings."). Furthermore, where the Examiner takes official notice of a fact unsupported by documentary evidence, the Examiner must provide a technical line of reasoning underlying the decision to take official notice. General conclusions about what is common sense to one of ordinary skill in the art, without specific factual findings or evidence on the record, are not sufficient to support an obviousness rejection.

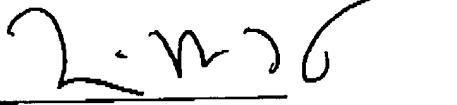
The Examiner has not provided evidentiary support for the asserted facts, and furthermore, the Examiner has not provided a technical line of reasoning supporting the decision to take official notice of what would have been obvious to one of skill in the art. Applicants submit that there is insufficient evidence to support a finding of obviousness. The Examiner has not made a *prima facie* case of obviousness, and Applicants respectfully request that the rejection be withdrawn.

In view of the above amendments and remarks, Applicants respectfully request a Notice of Allowance. If the Examiner believes a telephone conference would advance the prosecution of this application, the Examiner is invited to telephone the undersigned at the below-listed telephone number.

Respectfully submitted,

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26 March 2007  
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Journal of Natural Gas Chemistry 19(2004)1-9



## Development of a CO<sub>2</sub> Tolerant Fischer-Tropsch Catalyst: from Laboratory to Commercial-Scale Demonstration in Alaska

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[Manuscript received December 2, 2003; revised January 8, 2004]

**Abstract:** This article describes the development of BP's Fischer-Tropsch catalyst, used for the carbon monoxide conversion and hydrogen into liquid hydrocarbons. It covers the 18 year period from the early eighties, when laboratory scale preparations and micro-reactors were heavily used, right through to the present day with the commercial scale manufacture and proving of the finished catalyst in BP's new \$86 million gas to liquids demonstration facility in Nikiski, Alaska. Extensive performance testing and scale-up experiments have been successfully carried out, all proof that a laboratory preparation can indeed be translated into a commercial manufacturing process. In addition, the resulting catalyst does not only meet the process design targets, but also exhibits enhanced stability and is tolerant to carbon dioxide. Above all, a commercial scale, fixed bed Fischer-Tropsch catalyst is now available and ready for licensing. Manufacturing procedures and quality control have all been successfully detailed and transferred to the commercial manufacturer.

**Key words:** carbon dioxide, Fischer-Tropsch, development, syngas, commercial catalyst

### 1. Introduction

The Fischer-Tropsch catalyst lies at the heart of gas to liquids processes for the conversion of natural gas into transportation fuels. This catalyst should convert the CO and H<sub>2</sub> mixture (syngas), derived from the reforming of the natural gas, into liquid hydrocarbons which are pipeline stable. A commercial catalyst needs to meet strict criteria for activity and selectivity to liquid products and must be able to be manufactured on the multi-tonne scale.

Selectivity considerations are extremely important in the design of the Fischer-Tropsch (FT) section of a gas conversion plant. The catalyst must maximise the yield of liquid hydrocarbons and minimise production of methane, LPG and carbon dioxide since syngas production is expensive. Other consider-

ations are catalyst activity, which defines the reactor size and catalyst life, which, in combination with the heat management, influences the choice of reactor.

The choice of active metal has important implications for the selectivity of the catalyst and its cost. Iron catalysts are known to make large amounts of carbon dioxide via the water gas shift reaction and as such are generally considered unsuitable for operation in gas based FT plants. In addition, they tend to produce predominantly linear alpha olefins as well as a mixture of oxygenates such as alcohols, aldehydes and ketones. Of the other metals active for carbon monoxide (CO) hydrogenation, nickel is too hydrogenating and consequently produces excessive amounts of methane and ruthenium is expensive and relatively rare. This leaves cobalt which is a good choice in terms of cost and availability, the key being

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